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ABSTRACT

This paper advocates an integrated curriculum in which LOGO would play a role in the intellectual development of children. In particular, it is argued that curricular interventions that occur in the midst of spontaneous learning are most needed when major problems of transfer, generalization, and abstraction are to be solved or when children need assistance in finding knowledge. The integrated curriculum envisioned would not be age or grade specific, but would be developmentally based, reflecting the intellectual and emotional growth of the child. Teachers and other adults should intervene frequently in the LOGO experience in both formal and informal ways, particularly with regard to the introduction of commonly shared learning activities and vocabulary. In such interventions, LOGO should be presented as an important component in a curriculum of concrete experiences designed to help children integrate their learnings and transfer them to problem solving in general. Research that used LOGO to investigate the efficacy of computer use in the teaching of mapping skills to elementary school students identified four kinds of unanticipated problems: syntonic movement, language constraints, transfer of understanding and knowledge, and developmental constraints. Directions for further research are discussed. (RH)

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Imagery, Language, LOGO and Curriculum

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Abstract

Young children using LOGO are observed to have difficulties with measurement, rotation and body syntonics. Additionally there is little evidence of transfer of learning from the LOGO environment to other areas of knowledge. The authors propose that an integrated curriculum that places LOGO in a matrix of concrete and language experiences will enhance the imagery that the child is developing and thus strengthen the abilities of the child to comprehend and manipulate concepts. Such a curriculum would give great attention to the development of a functional language and a variety of concrete experiences designed to contribute to conceptual development. Finally the article discusses future needs for research and development.

Imagery, Language, LOGO and Curriculum

In this paper we will argue the need for an integrated curriculum in which LOGO would play a partial role in the intellectual development of children. Such a curriculum would encourage much spontaneous exploration of LOGO by children but would also call for teaching to provide a wide range of concrete and language experiences. We will argue that curricular interventions in the midst of spontaneous learning are most required when major problems of transfer, generalization, and abstraction need to be solved or when children need assistance in finding knowledge. The integrated curriculum that we envision would not be age/grade specific but would be developmentally based; reflecting the intellectual and emotional growth of the child. We have come to this position after careful examination of the difficulties encountered in LOGO instruction, body syntonicity and transfer of learning in a curriculum-free environment. In arriving at this opinion we have come to see that, in contrast to the assertions of Papert (1980, p. 8) that, "... the model of successful learning is the way a child learns to talk, a process that takes place without deliberate and organized teaching ...", we are more comfortable with the work of Margaret Donaldson (1978, p. 122) who says, "... children ... are beings with potential for

guiding their own growth in the end. They can learn to be conscious of the powers of their own minds and decide to what ends they will use them. However, they cannot do this without help -- or at least it would be a long slow business and few would make much headway."

We submit that teachers, or other adults, should intervene frequently in the LOGO experience in both formal and informal ways -- particularly with regard to the introduction of a set of commonly shared learning activities and a commonly shared vocabulary. In these interventions LOGO should be presented as an important component in a curriculum of concrete experiences designed to help children to integrate their learnings and transfer them to problem solving in general. The idea that such interventions are required, even in an environment of discovery, is not a new one. Donaldson (1978, p. 106) reminds us of Lauren Resnick's argument that we are "... not faced so much with a choice between teaching by rules and teaching by discovery as with a problem of finding teaching rules that will enhance the probability of discovery." The difficulty of presenting such a proposition in relation to LOGO is that a mythology has begun to form around LOGO which suggests that any intervention by the teacher will nullify the discovery and wonder of the microworlds of LOGO.

It is widely assumed that children's experiences in the exploration of LOGO should be as spontaneous as possible: i.e., after certain minimal introductory work with children the teacher should, if anything, play a purely facilitative role in response to student questions as they arise out of undirected exploration. Included in this assumption are two related ideas: a) that the language children use to talk about the LOGO experience should also be derived spontaneously from the language that children use to talk expressively with one another (and the teacher) — not a planned, formalized, or standardized language developed through systematic intervention by teachers; and b) that there is no need to provide a planned curriculum of non-computer activities that might be integrated with LOGO experiences in the development of intellectual skills.

As an extention of these assumptions it is also assumed that the movement of the turtle is body syntonic, and once mastered on the screen is thus easily understood and readily transferred to the solution of physical and intellectual problems in the real world or conversely, once tested in the real world a movement is easily understood and transferred to the microworld of LOGO.

The preceding assumptions raise the fundamental issue of the likelihood of LOGO learning being spontaneously transferred to

general intellectual development or problem solving outside of the setting in which it is learned. Papert (1980, p. 8) says that his work has been based on the belief that "... children can learn to use computers in a masterful way, and that learning to use computers can change the way they learn everything else ...".

The Calgary Investigation

We have chosen to do our work using a Piagetian perspective accepting that, until otherwise established, Piaget's fundamental conclusion's about child development are essentially true. Concurrent with that we are entertaining Papert's idea that child development can be influenced by the concrete interaction with computers.

Mapping has been our particular interest. We are aware that most mapping programs are developed with Piaget in mind. We are also aware that there are many elements of mapping skill acquisition that are not well understood. For example, while Sime (1973, p. 30) says Paiget's testing of young children to penetrate their understanding of spatial layout should give us a warning that in most young children there is insufficient pre-mathematical foundation for them to understand many of the tasks involving maps, charts and map-drawing that are set for them, Donaldson (1978, p. 24) says that when similar tests are given based on "human sense" and

comprehensible motives and intentions children do substantially better than those tested in the abstract of Piaget.

In addition to considering relevant data on child development and mapping skills it is also important to consider the implications of computers as Papert sees them. Will the use of computers give children mapping experiences hitherto unavailable to them, and, will such experiences contribute to changes in the timing and proficiency with which children can read, construct and use maps? From our very early experience, for example, we have learned that it is possible, with a microcomputer and LOGO, to create situations using a scale model that children could not before have experienced.

Our first limited investigation of the efficacy of computer use in the teaching of mapping skills with elementary grade students (Taylor, 1985, chap. 6) led to the formation of an hypothesis and two questions. The hypothesis -- "Interactive uses of computers, including the use of the language LOGO, can be an effective part of the teaching of mapping skills to elementary students." The questions -- "When in the intellectual development of the children should the various concepts of mapping be introduced?" and "What role in mapping literacy will the computer play?"

Using LOGO with children was seen as a good place to begin to identify mapping awareness in children. The map concepts of directionality, scale, distance and location are closely related to geometric concepts and LOGO allows for the effective demonstration and manipulation of such concepts. The body syntonic claims made for LOGO suggest that this language should naturally contribute to spacial understandings that children will develop as they become proficient map readers and map makers. Propelling the turtle around its environment should lead naturally to propelling the turtle through mazes and on maps.

Our second investigation began in the fall of 1984 when computer learning centres were established in each of two grade one classes being operated in a team teaching area in a school in Calgary. The community in which the school is located might be described as a new, young, working-class community (the school was in its second year of operation when our investigation began). If anything about the classes might appear as atypical it is that there is a fairly high percentage (up to 30%) of English-as-a-Second-Language students. The classroom teachers might also be described as average or typical, competent and dedicated. Teacher one had 40 hours of computer in-service, 20 with BASIC and 20 with LOGO and had a very positive attitude toward computer use in the

classroom. The second teacher had only 20 hours of in-service with BASIC and was frankly sceptical of computer potential in the classroom because of her own unsatisfactory experience. The two teachers, with teacher one as team leader, did all the instruction on LOGO while the university researchers, both of whom have extensive experience as classroom teachers, conducted observations of the children at work.

The teachers were encouraged, in our planning meetings, to use a directed inquiry approach. They introduced the turtle, commands that could be used, and, after a time of non-directed exploratory activity, suggested activities that the children could use in their explorations. Some examples were, "Make a drawing on paper that you can do on the computer." or "Can you make something that has two parts that are not connected?" or "Can you draw something inside something else?" (These two suggested after the PENUP command had been introduced.) or "Can you draw a house and write it down so that someone else can follow your instructions?" The children called the results of these suggested activities their "plans". Sometimes the plans began with the computer; sometimes they began with pencil and paper and ended with the computer.

Because the children were young, unfamiliar with the keyboard, working mainly with numbers less than ten and, in some cases,

lacking in letter recognition skills an instant utility (Abelson, 1982, p. 117) was used. The children worked in pairs for approximately twenty-minute periods whenever they had time or the teacher directed them to the computer. As with other learning centres in the classroom area most of the childrens' activities at the computer were free of teacher intervention. The teacher went to the centre when she had a moment to observe, when the children had a problem they could not solve or, most frequently, when the children had a product of which they were particularly proud. The university observers limited their activities with children to the asking of questions (although it must be stated that in some instances the questions served to direct the children to new areas of exploration). Each pair of students averaged two periods a week on the computer.

Developing strategies with children and teachers and working on applications with them we came to see some unanticipated problems. At first appearance these problems seemed to take us away from questions about mapping skills but, on closer examination, are very significant in the development of a curriculum for teaching mapping skills. They also brought us to a consideration for the need for a clearer definition of learning and teaching strategies to be used with LOGO and the possibility that such strategies can be embedded in an integrated curriculum.

We have chosen to define the unanticipated problems under four broad headings. In the following portion of the paper we will describe the problems individually and then we will discuss means for addressing them. While it seems possible to separate the problem areas it seems that solutions are interlocking and revolve around language and imagery development -- hence first the separation, then the uniting.

Syntonic Movement. Much of the literature surrounding LOGO use holds great hope for the opportunities provided when children "play turtle" as they seek solutions to problems.

> Pretending to be the Turtle was a popular activity from the beginning and it was a strategy on which the children relied when they were confused about direction. They would stand up and move on command, taking small Turtle steps. At first the commands were issued by the researcher (FD 10, BACK 3) to the child/Turtle. Later the roles were switched. One child wanted to put his arms in front of his body, with his elbows out and his fingers touching. This posture resembled the triangular form of the Turtle. His mother reported that he liked to do that at home, too. (Hines, 1983)

We were puzzled then, by the apparent unwillingness of the children to engage in such activity. Our observation children

would play turtle when encouraged or instructed to do so by their teachers but their movements tended to be stilted and unrealistic and often contributed nothing to the solution of the problem. It should be made clear that, in neither of these classes was spontaneous movement frowned upon; children moved about, sat or sprawled on the floor to work puzzles or read books; and were often physically active while at work. In thirty half-day observations spread over eight months we saw no evidence of spontaneous use of body to "figure out" what to do. Our observations were further confirmed when informal interviews with three computer consultants employed by the Calgary Board of Education revealed that they, too, saw a reluctance on the part of students to play turtle. They had not spoken to others about it because they felt it was the result of some flaw in their teaching strategies.

Papert (1980, p. 58) says, "The child is encouraged to move his or her body as the turtle on the screen must move in order to make the desired pattern". We began to wonder what, exactly, "encouraged" means and to ask whether enough attention has been given to the practicalities of syntonic movement in problem solving in the classroom.

Language Constraints. In using a directed inquiry approach the amount of formal, standard language inserted by the teacher is

small. Yet without such language the children have difficulty in talking out problems with each other -- and they have trouble sharing ideas and solutions that they have developed. James Britton (Nystrand, 1977, p. 44) says that talk is habitually used in at least two ways; "... to go back over events and interpret them, making sense of them in a way that we were unable to while they were taking place ...", and, "... as a means of modifying each other's representations of experience ...".

Our observations led us to believe that the most serious deficiency of the language available to our observation children had to do with the words and phrases used to describe turtle movement. It seems likely that later the difficulties would be with insufficient programming vocabulary. We know that children acquire language on their own but we also know that formal instruction, whether by parents or teachers, is used to develop the standard language necessary for humans to converse about ideas and abstractions; to interpret events and modify representations. Has enough attention been given to the language necessary to support strong, lasting images for thinking with computers and LOGO?

Transfer of Understanding/Knowledge. We saw opportunities for transfer of knowledge/understanding lost because the currently available literature does nothing to encourage the teacher to take

advantage of them. For example, we saw the phenomenon of children able to use left/right commands who were still unable to identify left/right on their own bodies and, while these two are not necessarily connected in the mind of the child they might have been if that had been deemed a valuable thing to do and if opportunities had been siezed to assist the children in transferring their understanding from one domain to another.

The question of transfer of thinking skills is not a new one. An example of such a debate in the educational community was the study of Latin and its ability to develop logical thinking and intellectual activity. (Grose, Birney, 1963, chap. 2) Now we ask; has enough attention been given to the effectiveness of knowledge transfer from computer situations to other microworlds -- or the real world?

Developmental Constraints. We have come to believe that there are developmental constraints on most children aged 6-7 that limit their ability to determine the differences of; movement as a change in location, and movement as distance traversed. Our observations would lead us to believe that, for the most part, the children did not really see turtle turns but rather saw only the linear movements of the turtle.

We first observed the phenomenon after four months of computer work when the teachers asked the children to write "programs" using the single letter commands of the instant utility and a number which would indicate the number of times they intended to press the key. Their programs looked like this;

F 3

R 3

B 4

L 5

R 4

L 2

When they executed their programs they were always disappointed that, given a series of turns, the turtle didn't do anything". Discussion with the children as to what they might do with their programs to make them work better occasionally brought the response that, "you shouldn't put left's and right's together", but most children chose to attempt to increase the size of the numbers in order to get the turtle to do more.

Other educators seem to have made the same observation. In their book Logoworlds Heller, Martin and Wright (1985) refer to the difficulty on more than one occasion. First they speak of an error when they say, "The most common error children make in using LEFT

and RIGHT is that they think that the turn will also cause forward motion of the turtle." Later they cite misinterpretation by saying, "Children often misinterpret the directional moves of the screen turtle, declaring 'Nothing happened'." but do not consider the possibility that it has something to do with the stage of development of the child. This possibility is ignored even though observation of the children suggests that what we are seeing are elements of the transformation phenomenon identified by Piaget as part of the developing of a pre-operational child. The difficulties the children experience may not be either "errors" or "misinterpretations" in the conventional sense but rather manifestations of their development. We have not been able to find evidence that anyone has attempted to get to the root of this, nor to suggest pedagogy which would be in keeping with the resolution of the difficulty except for Heller, Martin and Wright (1985, p. 221) who propose a body syntonic solution by suggesting that "Pivoting can best be understood by actually turning while staying in the same place. Games like Turtle Spin and Maze Walk help children internalize both direction and distance."

We wonder if we should wait until children are past this developmental marker before introducing them to LOGO or should we introduce more talk into the activities to aid the children? Is

there some other solution? And what implications, if any, does this have for the introduction of children to mazes and/or maps? We hope that elements of our longitudinal study will contribute to the answer.

Summary of Concerns. All the difficulties we observed, and the frustrations the children experienced, seem in some way to be connected to the lack of imagery supported by vocabulary and language. Such an imagery and related language should be meaningful in the moment and continue to be functional as the child develops to fully operational thinking. Let us be clear, LOGO itself, is a functional language both for young children and for those who are capable of operational, and even formal, thinking but the language we have been using to talk about LOGO has little such functionality. For example, manuals and articles designed to assist teachers in using LOGO with children refer to "turtle steps" and "the rule of 360" as ways of describing turtle movement and assisting children to use their own bodies in solving problems. However, close examination of children's activities makes it clear that such non-specific use of language does neither.

The turtle takes two distinctive kinds of steps; travelling steps and turning steps. These are quite different in both execution and result. Travelling steps result in linear pixel by

pixel movement; turning steps are pivotal and are done in degrees. The turtle leaves no mark when it takes a turning step (part of the problem our children were experiencing) and the movement appears to be a wink of light rather than a movement. Playing turtle does not assist the child with such a perceptual problem nor does the non-specific language that teacher manuals currently provide. Would careful discussion of the movement of the turtle, with attention to the language used to describe those movements, assist the children to see and understand what is happening?

Some, such as Daniel Watt seem to think so. In his manual Learning With Apple Logo Watt (1984, p. 29) says,

> If you're working with a group of students, a good way to emphasize this kind of learning is to pose an exploration problem and ask them to share possible ways of finding the answer. Then, after everyone has worked on the problem, ask people to share what they did and how they thought about it. In the long run, establishing an environment in which a process and the thinking behind it can be discussed (and even argued about) is the most important 'learning goal' that you can pursue through explorations.

While Watt does not specify what kinds of problems might be posed, with what age children or how such discussions will further the

acquisition of learning strategies it is implied that there would grow and develop out of discussion a common imagery/vocabulary/ language that would be useful to all participants.

Some further discussion of playing turtle is required. It seems that the romanticizing of the syntonic relationship of child and turtle has caused us to overlook some rather obvious differences between the two. The turtle is a two dimensional figure, the child a three. The turtle moves on two planes, the child on three. The turtle executes movements one at a time, children are all over the place at once. Many of the turtle movements are flickers or blinks, children may seem to disappear in the blink of an eye but their movements are naturally fluid and observable. The speed of the turtle's movement is quite constant while children's speed of movement is directly related to the intent of the task. With careful thought, strategic intervention by the teacher, and a standardized vocabulary the child can come to mimic the turtle but the turtle cannot always replicate the movements of the child. If this is worked out — talked out — with the children would they be more willing to play turtle as a means of examining problems?

The question of transfer of learning is one of the most vexing in education. It is known that it is difficult and little has been

said about how it might be done. Yet our experiences tell us that the knowledge that is most useful is that which is generalizable to many situations. That, we believe, is what Papert hoped for and what is seen as part of sound problem solving strategy. Yet without a) repeated experiences and, b) processing through discussion or experimentation in other settings, can knowledge be moved readily from domain to domain?

Our six and seven year old children did not have a good command of left and right on their own bodies but they came to know well the left and right moves of the turtle. This was confirmed when a left/right check was done with twenty of the children after four months of LOGO use. While the children showed a basic understanding of laterality, i.e., everyone has lefts and rights and these line up consistently on one side of the body so that the left ear and the right eye cannot be on the same side of the body; they were unable, with assurance, to identify their left or right. At the same time they demonstrated the ability to move the turtle left and right appropriately and confidently. In retrospect it is unfortunate that no attempt was made to capitalize on the learning which had occurred with the turtle and transfer the left/right assurance to their own bodies and then, later to maps and map making. So thoroughly has the literature surrounding LOGO

indoctrinated the teachers that LOGO learning will almost magically create better mathematically oriented, problem-solving children that it did not occur to the teachers to discuss LOGO learning in such a way as to facilitate its transfer to other situations.

The Future

A high priority need is the need for an imagery supported by suitable vocabulary and language for use in discussing LOGO. This language should deal with the literality of children and allow for the construction of images that will;

1) not need to be rejected as new knowledge is added;
2) will continue to be functional even as they are refined as children move from pre-operational to concrete to formal thinking;
3) that will facilitate transfer of knowledge to other domains.

It is necessary to be more analytical about the role of body syntonics and those turtle movements that are amenable to mimicry in natural body movements -- we should not romantisize the role of playing turtle in the acquisition of power over the learning experience. While it is fine to trust our intuitions in the use of body movement in the acquisition of concepts such movements need not be standardized or prescribed for all learners; attention must be given to the facts that children come from varying previous

experiences and varying learning style needs. Some learners probably minimize the kinesthetics and maximize expression through mental imagery. Some will bring such a wealth of early kinesthetic experiences (or adequate kinesthetic experiences for their learning style) that they are ready and able to work in the imagery mode with small amounts of assistance from new body experimentation. Because of the differences in both learning style and stages of development we should look at all the available ways to play turtle and assist the children to use their bodies, their toys, their pencils, etc. in meaningful, but not prescriptive, ways.

We need teacher manuals, aids, etc. that do not treat LOGO as a panacea, or a simply applied instructional tool. In these aids time and attention must be given to not only the elements of the imagery itself but to the means by which transfer of concepts might be achieved. The transfer should always be seen as two-way; from the computer to other knowledge domains and from more traditional disciplines to the computer.

Instructional sequences sensitive to Piaget's findings should be devised and carefully observed. These should provide a starting place open to the possibility that LOGO may accelerate and enrich the development of thinking skills. Teachers should be encouraged to be reflective in their use of such strategies.

Observations, in the Piagetian spirit, should be carefully made in regular classrooms with regular students. In making these observations care must be taken not to project the wonder of the computer onto the reality of the moment. The possibility that computer as tutor, tool or tutee is inappropriate for children of some ages or stages should be held open. Nothing has yet proven that interactive computer use is appropriate for all children at every stage in their development.

Research must continue, and as difficult as it is, a major thrust should be in the examination of transfer of learning and particularly transfer of problem solving skills from domain to domain; from microworld to microworld and from microworld to real world.

If we can bring together new understanding of the relationships of LOGO use and child development along with instructional sequences sensitive to those relationships then we will have the core of an integrated curriculum. Add the imagery, the vocabulary, the language, and the understanding of body syntonics and the curriculum will have shape and life. Next we should seek out those areas where transfer of learning is appropriate, those areas were integration with other curricula are obvious and focus our energies on the integration of LOGO into all suitable areas of learning.

Then we can write the manuals, teacher aids and support materials. We have, unfortunately done the last thing first.

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